GROUP 54C

CONTROLLER AREA NETWORK (CAN)

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GENERAL INFORMATION

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CAN, an abbreviation for Controller Area Network, is an ISO-certified international standard for a serial multiplex communication protocol[*1]. A communication circuit employing the CAN protocol connects each ECU, and sensor data can be shared among, which enables more reduction in wiring.

*NOTE: [*1]: The regulations have been decided in detail, from software matters such as the necessary transmission rate for communication, the system, data format, and communication timing control method to hardware matters such as the harness type and length and the resistance values.*

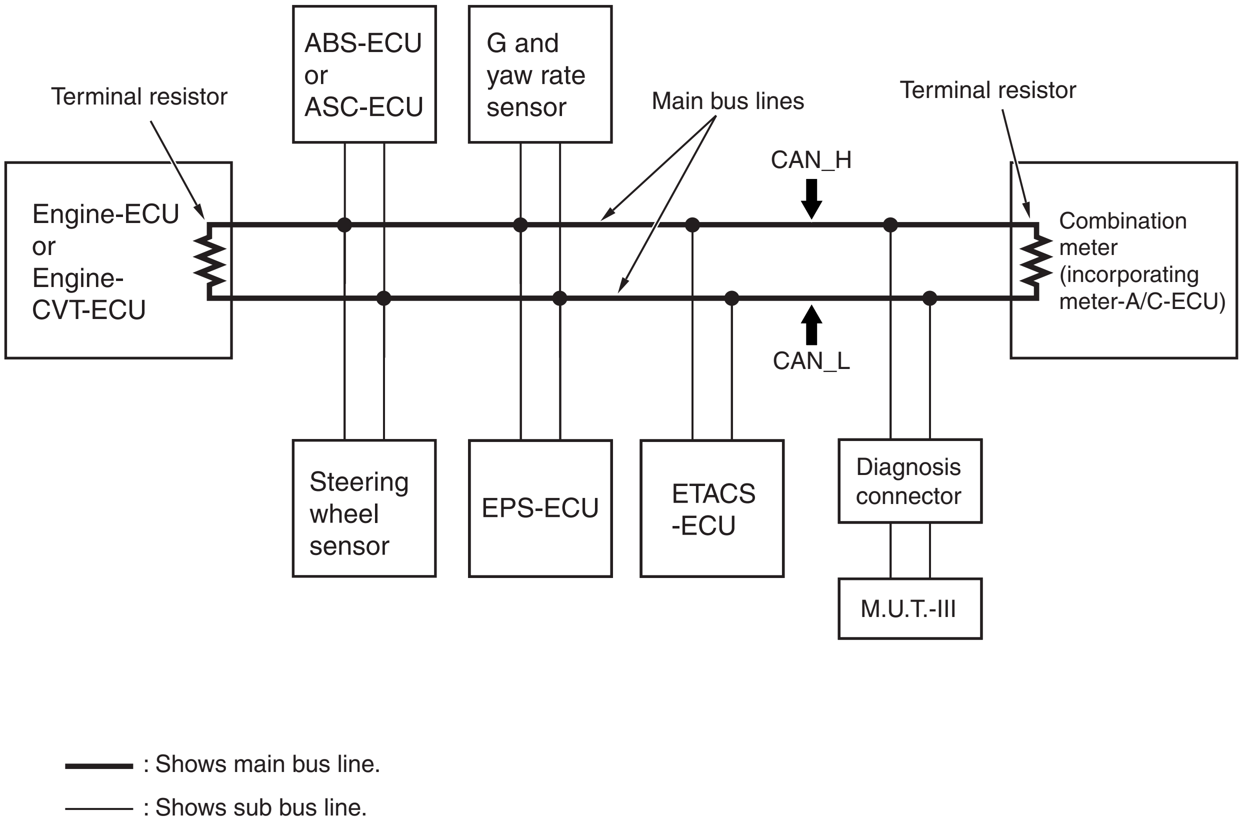
CAN offers the following advantages.

- Transmission rates are much faster than those in conventional communication (up to 1 Mbps), allowing much more data to be sent.
- It is exceptionally immune to noise, and the data obtained from each error detection device is more reliable.
- Each ECU connected via the CAN communicates independently, therefore if the ECU enters damaged mode, communications can be continued in some cases.

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STRUCTURE

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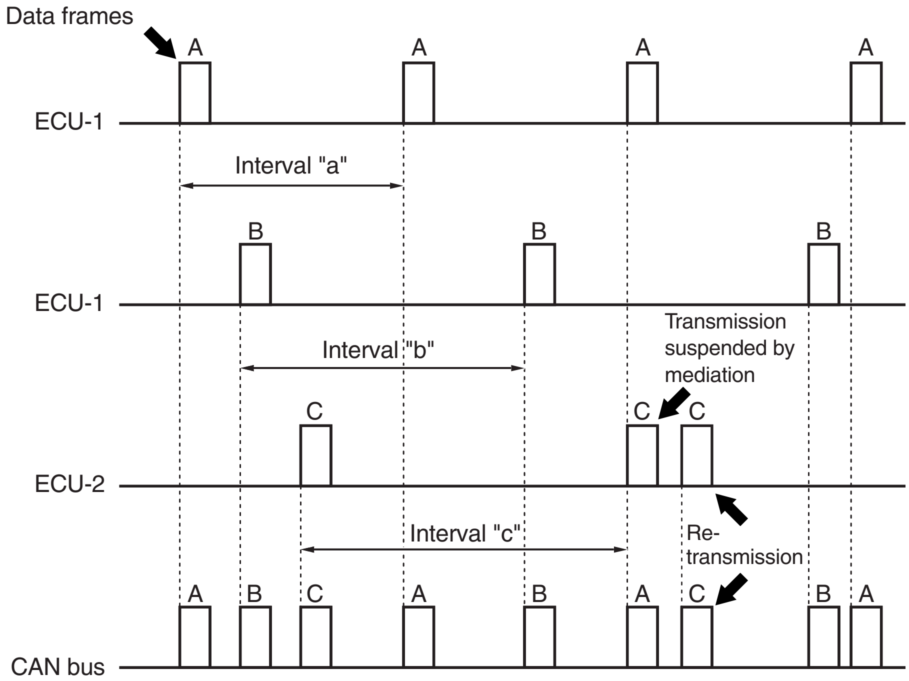
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- The CAN bus line consists of two lines, CAN_L and CAN_H (CAN Low and CAN High, respectively), as well as two terminal resistors (A twisted-pair cable, highly resistant to noise, is used for the communications line).
- The CAN bus line connecting the two terminal resistors is the main bus line, and the CAN bus line connecting each ECU is the sub-bus line.
- The terminal resistors are installed in the engine-ECU <M/T> or engine-CVT-ECU <CVT> and combination meter (incorporating meter-A/C-ECU) to stabilize communication signals (The terminal resistance is set at approximately 120 Ω).
- ECUs are connected in the CAN bus line as follows.
  - Engine-ECU <M/T> or engine-CVT-ECU <CVT>
  - ABS-ECU <vehicles without ASC> or ASC-ECU <vehicles with ASC>
  - G and yaw rate sensor <vehicles with ASC>
  - Steering wheel sensor <vehicles with ASC>
  - EPS-ECU
  - ETACS-ECU
  - Combination meter (incorporating meter-A/C-ECU)

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OPERATION

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The CAN communication system is described below.

- Each ECU communicating with CAN periodically sends several sensors' information on CAN bus as data frame (called periodical sending data). For further details, consult the data frame section.
- ECUs requiring data on CAN bus can receive data frames sent from each ECU simultaneously.
- The data sent from each ECU conducting CAN communication is transmitted at 10-1000 msec interval depending on necessity of data.

NOTE: In the figure above, the data frame A is transmitted in "a" intervals, while the data frames B and C are transmitted at intervals "b" and "c," respectively.

- A single ECU transmits multiple data frames.
- When data frames conflict with one another (when plural ECUs transmit signals simultaneously), data is prioritised for transmission by mediation, therefore, plural data frames are not sent simultaneously. For further details, consult the mediation section.
- Data is transmitted not by the conventional voltage-using method but by voltage potential difference. For further details, consult the section on CAN bus voltage transformation .
- Reliability of each ECU transmitting signals via CAN communication is secured by several error detection and recovery processes. For further details, consult the sections on error detection and system recovery.

MEDIATION

Because each ECU transmits data independently on the CAN bus, there are cases of data collision when multiple data frames that ECUs attempt to transmit simultaneously (if multiple ECUs transmit at nearly the same moment). At this moment, processing of the ECUs attempting transmission is performed in the following way.

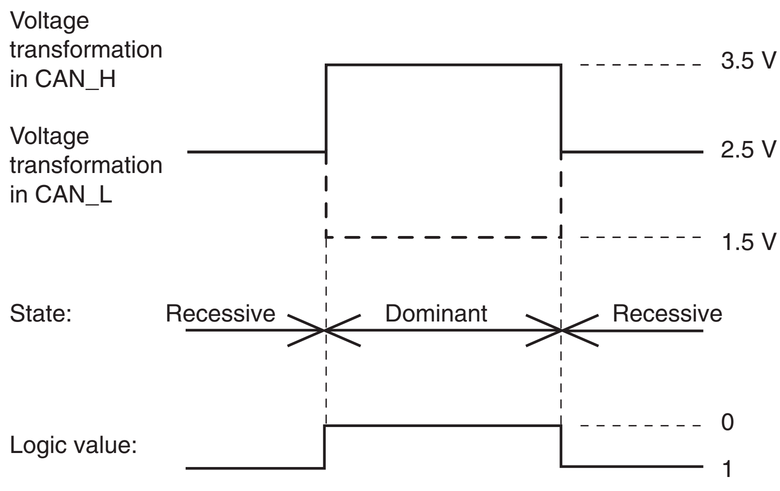
1. Data frame with high priority is transmitted first according to ID codes memorized in data frames.
2. Transmission of low-priority data (data frames) is suspended by the issuing ECUs until the bus clears (when no transmission data exists on the CAN bus).

NOTE: If the suspended state continues for a specific time, new data (data frame content) is created and sent.

3. ECU containing suspended data frames transmits the data when the bus becomes available.

NOTE: There is enough capacity on the CAN bus, which never prevents data frames from being sent.

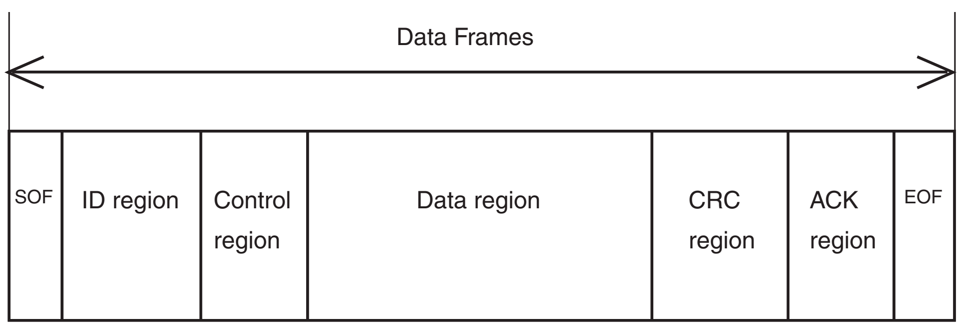
VOLTAGE TRANSFORMATION ON THE CAN BUS



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Data frame transmission through the CAN bus line involves voltage transformation (for output signals) in the distinctive CAN profile as follows. The ECU transmitting through the CAN_H and CAN_L bus lines sends 2.5-3.5V signals to the CAN_H side and 2.5-1.5V signals to the CAN_L side. The receiving ECU reads the data from the CAN_H and CAN_L potential difference. "Recessive" refers to the state where both CAN_H and CAN_L are under the 2.5-V state, and "Dominant" refers to the state where CAN_H is under the 3.5-V state and CAN_L is under the 1.5-V state. By transformation mainly to 2.5V, even in cases when voltage is rendered 0 from faulty grounding or the like (causing a problem of an approximate 0.5 voltage increase on the communications line), communication can be continued uninterrupted. Employing dual communications lines improves reliability to prevent the presence of noise, compared to the conventional communication method.

DATA FRAMES



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SOF (Start of Frame)

- Indicates the start of the frame

ID (Identifier) region

- Identifies the data content while specifying priority rank in case of mediation

Control region

- Specifies the frame type, data length, etc.

Data region

- Values used for data control, etc.

Cyclic Redundancy Check (CRC) region

- Region where to check for errors in sent data, the transmitting ECU calculates data regions by applying prescribed operations and stores the results. The receiving ECU detects erroneous communication by comparing the CRC region with the data region.

ACK (Acknowledge) region

- Region where to conform the reception of sent data

EOF(End of Frame)

- Indicates the end of the frame

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ERROR DETECTION AND RECOVERY

CAN protocol secures its reliability of communication by providing several error detection function such as CRC shown in data frame, and the recovery function (recovery is performed by resending, from abnormal state such as transmission errors). If an error is detected but it is not resolved even after recovery, communication is stopped. This state is called "Bus Off."

SELF-DIAGNOSIS

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- CAN self-diagnosis is performed by each ECU connected to the CAN bus.
- diagnosis codes related to communication are named with the capital letter U, and are called "U-codes."
- A summary of the CAN self-diagnosis system is presented below.

TIME-OUT

Each ECU transmits data frames periodically. If the data frame is not received within the specified period, the intended receiving ECU transmits a diagnosis code indicating communication time-out for the ECU that failed to transmit.

BUS OFF

Related to a communication error that persists even after the transmitting ECU attempts recovery for a specified number of attempts or that persists for a specified period after recovery, communication is stopped and this diagnostic code is issued.

FAILURE DATA

When the transmitting ECU detects failure of a sensor directly connected to it, this is the pertinent data used to inform the ECU.

DATA LENGTH ERROR

When the number of data bytes received is different from the prescribed number of bytes, this diagnosis code is issued.

DYNAMIC RANGE ERROR

When the data received is more or less than the prescribed range, this diagnosis code is issued.

CAN BUS DIAGNOSTICS

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As ECUs are connected via CAN bus (including M.U.T.-III), always diagnose CAN bus to confirm its normality when inspecting. Simply by performing M.U.T.-III screen operations, the following inspections can be performed automatically, and the result can be used to verify the CAN bus status.

- Voltage measurement between the CAN_L and CAN_H and the body earthing terminal
- Resistance measurement between the CAN_L and CAN_H
- Confirmation of communication of all ECUs